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NESTING AND FOOD HABITS OF THE FLAMMULATED OWL (*OTUS FLAMMEOLUS*) IN SOUTHCENTRAL IDAHO

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ABSTRACT.—Flammulated owls (*Otus flammeolus*) arrived at our 25-km² study area in Idaho from mid- to late May 1991–94. Twenty-four nesting pairs utilized 22 nesting cavities. Twenty (83%) of the nests were in dead trees and four (17%) in live trees. Thirteen (54%) nests were in broken-top Douglas-fir (*Pseudotsuga menziesii*) snags, and 11 (46%) were in trembling aspen (*Populus tremuloides*). Mean diameter at breast height of 13 nest trees was 49.9 cm (SD = 18.9), while mean cavity height was 5.1 m (SD = 0.6). Mean entrance diameter for 11 nests was 6.8 cm (SD = 1.3). Mean hatching date at 11 of the 24 nests was 26 June (range, 12 June through 11 July) and mean fledging date was 18 July (range, 7 July through 2 August). Mean brood size for nine nests was 2.3 (range, 2–3) young per nest. Nightly food deliveries at nest sites peaked within the 2-hr period after dark and before daylight. Mean number of nest visits by adults during the nesting stage was 93. Although lepidopterans comprised 79% and orthopterans 0.3% of the available prey within the study area in 1992, 65 food deliveries at one nest revealed 43.1% orthopteran and 9.2% lepidopteran prey. At other nest sites, lepidopterans were the prominent prey. Four banded owls returned to the same territory for two, three, and four consecutive nesting seasons.

KEY WORDS: *flammulated owl*; *food habits*; *Idaho*; *nesting*; Otus flammeolus.

Nidificación y hábitos alimentarios de *Otus flammeolus* en el centro-sur de Idaho

RESUMEN.—*Otus flammeolus* arribó a nuestra área de estudio de 25 km² en la segunda quincena de mayo de 1991 a 1994. Veinticuatro parejas nidificantes utilizaron 22 cavidades. Veinte (83%) de los nidos se ubicaron en árboles muertos y cuatro (17%) en árboles vivos. Trece nidos (54%) se encontraron en ramas alta quebradas de *Pseudotsuga menziesii* y 11 (46%) nidos estaban en *Populus tremuloides*. El diámetro medio a la altura del pecho de 13 árboles con nidos fue 49.9 cm (DS = 18.9). Mientras la cavidad se ubicó a una altura media de 5.1 m (DS = 0.6). El diámetro medio para la entrada en 11 nidos fue de 6.8 cm (DS = 1.3). La fecha media de eclosión en 11 de los 24 nidos, ocurrió el 26 de junio (rango 12 de junio hasta el 11 de julio). La fecha media del estado volantón fue el 18 de julio (rango 7 de julio al 2 de augosto). El tamaño medio de nidada para nueve nidos fue de 2.3 (rango 2–3) juveniles por nido. La alimentación nocturna en el nido ocurrió en el período de dos horas despues de hacerse oscuro y dos horas antes de la luz diurna. El número promedio de visitas al nido por adultos, durante el estado de pollo, fue de 93. Aunque los lepidópteros constituían el 79% y los ortópteros el 0.3% de las presas disponibles en el sitio de estudio en 1992, 65 entregas de alimento en un nido revelaron que las pesas estaban constituidas por un 43.1% de ortópteros y un 9.2% de lepidópteros. En otros nidos, los lepidópteros fueron las presas dominantes. Cuatro búhos marcados retornaron al mismo territorio, por dos, tres y cuatro estaciones de nidificación consectivas.

[Traducción de Ivan Lazo]

Until recently the flammulated owl (*Otus flammeolus*) was one of the least-known species of owl occurring in the mountain forests of western North America (Reynolds et al. 1989). Ranging from British Columbia to Central America, this small, cavity-nesting, predominantly insectivorous owl was formerly considered rare throughout much of its range (Bent 1938). Recent studies, however, have found it to be present in Montana (Holt et al. 1987) and fairly common in portions of California (Winter 1974, Marcot and Hill 1980), Colorado (Linkhart and Reynolds 1987), New Mexico (McCallum and Gehlbach 1988), Oregon (Bull and Anderson 1978, Goggans 1986, Bull et al. 1990) and British Columbia (Cannings et al. 1978, Howie and Ritcey 1987). The flammulated owl is presumed to be migratory at least within the Canadian and United States portions of its range (Reynolds et al. 1989) with supporting evidence for such being documented in New Mexico and Arizona (Balda et al. 1975).

Flammulated owls occur in Idaho (Larrison et al. 1967, Burleigh 1971) and although their distribution

and nesting status have been documented (Hayward 1986, Atkinson and Atkinson 1990, Moore and Frederick 1991), their breeding biology has received little study within the state. Currently the owl is listed as a species of special concern by the Idaho Department of Fish and Game and as a sensitive species (Moseley and Groves 1994). The status of this owl is in further jeopardy because it is a Neotropical migrant (Saab and Groves 1992). Objectives of our study were to document the occurrence, nesting activities and food habits of flammulated owls in the west portion of the Sublett Mountains during four nesting seasons, 1991–94.

STUDY AREA AND METHODS

The Sublett Mountains are approximately 68 km southeast of Burley, Cassia County, Idaho on the east edge of the Raft River Valley. Scattered Utah juniper (*Juniperus osteosperma*) communities skirt the lower regions and isolated pockets of trembling aspen (*Populus tremuloides*) and Douglas-fir (*Pseudotsuga menziesii*) are found at upper elevations, especially along north-facing slopes and draws. Our study area encompassed six dry canyons running north into the South Fork of Sublett Creek drainage. Topography is characterized by narrow canyon bottoms and moderate side slopes with elevation ranging from 1540–2200 m. Annual precipitation, primarily snow, varies from 25–75 cm and temperatures range from −37–38°C (J. Chard pers. comm.). Forest vegetation is predominantly aspen and Douglas-fir. Vegetation types in the study area are primarily sagebrush–grass, mountain shrub, riparian with scattered forbs, and grassland types. With the exception of scattered springs or seeps, there is no running water in any of the canyons studied.

Approximately 8 km^2 in Beaverdam and Twin Canyons were surveyed for owls in 1991. We expanded our surveys to approximately 25 km^2 in 1992 including an unnamed canyon ("Fenceline"), Kossman, and Eyrie Springs Canyons.

In 1991 our study efforts centered in Beaverdam Canyon where field studies were conducted between 5 April and 22 September. During 1992 we continued our studies in Beaverdam Canyon between 15 May and 26 June, and on 26 June we expanded our study into "Fenceline," Kossman and Eyrie Canyons, visiting all three canyons between 27 June and 15 November. In 1993 field work was conducted within the entire study area between 10 May and 28 July. The 1994 study season began on 25 May and continued through 12 August. We visited each suspected and known nest site at least once each trip to the study area. Previous incidental observations on nest sites, nesting phenology and banding efforts in the study area by one of us (LP) dating back to 1983 are also included with these data.

During April (1991 only), May, and June we conducted nocturnal surveys of the study area using playbacks of tape-recorded calls between sunset and midnight. Areas where responses were obtained were flagged for diurnal revisitation and investigation. All living trees and snags bearing cavities were scratched (Bull et al. 1990) for determination of occupancy two or three times during June and July. In addition, we sometimes skylighted cavities (Reynolds and Linkhart 1984) and made nocturnal observations with night-vision optics to determine occupancy and stage of nesting phenology at their cavities. Activity at nest cavities was monitored by periodic diurnal visits, to confirm nocturnal visitation by adults, and nestling or fledgling food-begging vocalizations. All-night observations recording the time and number of adult nest visits were on two nights each at two nests.

At least once each trip to the study area, nocturnal prey was sampled with a standard black-light (ultraviolet) and 1.5 × 1.5 m framed sheet sampling station. Insect sampling was always done within one of the occupied owl territories. Insects captured were measured and categorized into size classifications of small (8–11 mm), medium (12–13 mm) or large (14–32 mm) body length (Balda et al. 1975). To determine prey selection, we photographed prey deliveries and visually documented prey by close observations of artificially lighted nest cavities.

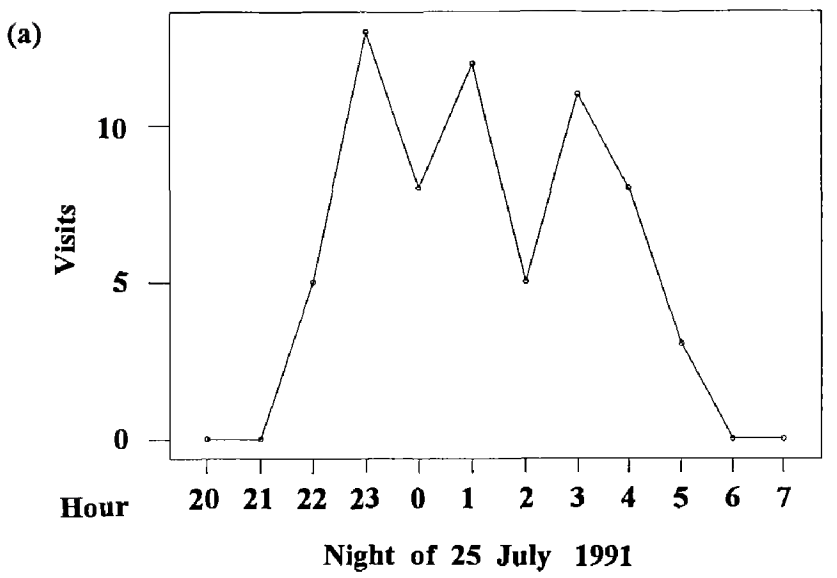
To determine nest site and mate fidelity and document individual activities at nest sites, owls were trapped and banded whenever possible. Adult owls were captured either in hand nets or mist nets placed in front of occupied nest cavities. All owls were banded with U.S. Fish and Wildlife Service aluminum bands.

RESULTS

Owls were first detected in the study area from mid- to late-May each year with the earliest date being 16 May 1993. April and early May playback tape surveys in the study area produced no vocalizing or other evidence of their presence. In the latter part of May and early June territorial calling by males and pair-bonding behavior, such as food solicitation callings (mewing) by females and allofeeding by males (McCallum 1994a), became more evident about prospective cavities. Such behavior was observed at three territories during the night of 9 June 1993.

Twenty-four nesting attempts by flammulated owls utilized 22 different nest cavities during our study (two of the cavities were occupied twice in consecutive years). Including previous observations of an active nest in 1983 and two others in 1988, 14 nests were found in Beaverdam Canyon, one in west Twin Canyon, four in Kossman Canyon, two in Eyrie Canyon and three occurred in "Fenceline" canyon between Twin and Kossman Canyons. The number of known nesting pairs was three in 1991, four in 1992, eight in 1993 and six in 1994.

We were able to determine brood size at only nine of our 24 nests. Single fledglings were observed at two additional nests. Three of the nine nests produced three nestlings each and the rest contained two young each ($\bar{x}$ = 2.3).



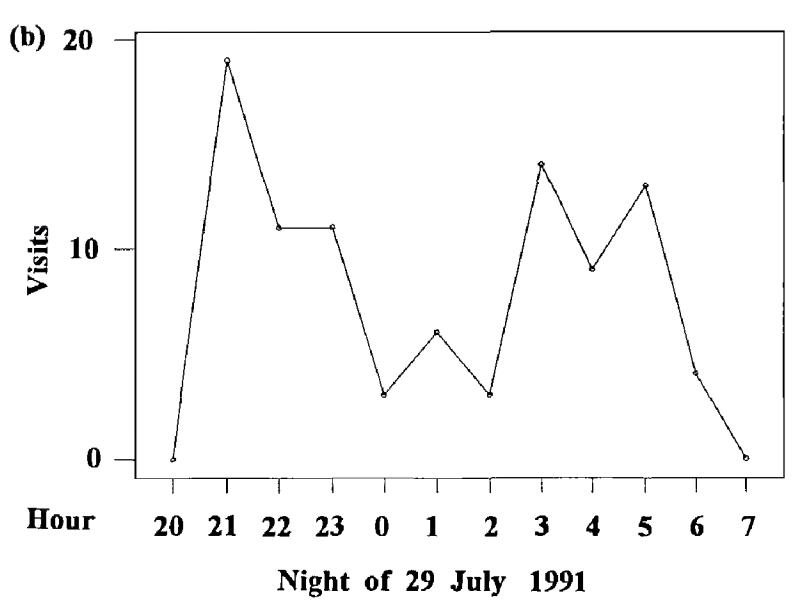
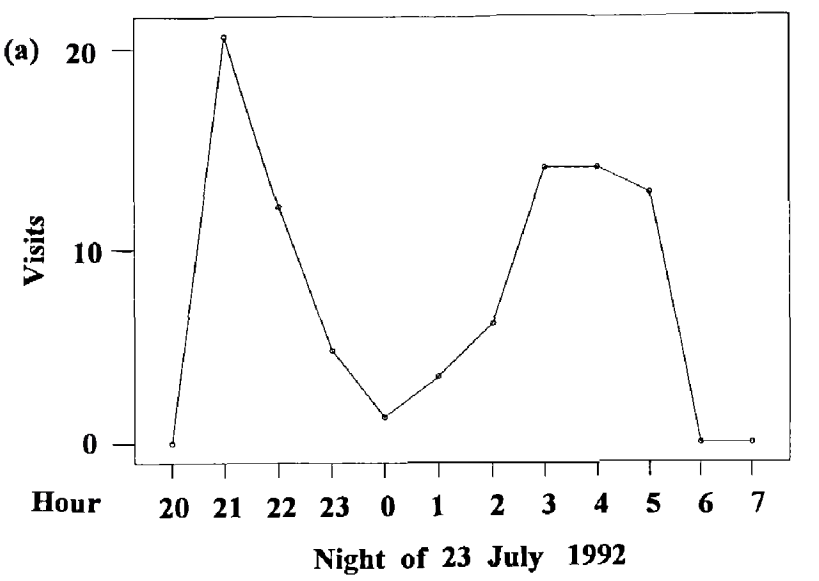


Figure 1. Nest visits by flammulated owls at Side Canyon during the nights of 25 July (a) and 29 July (b), 1991.



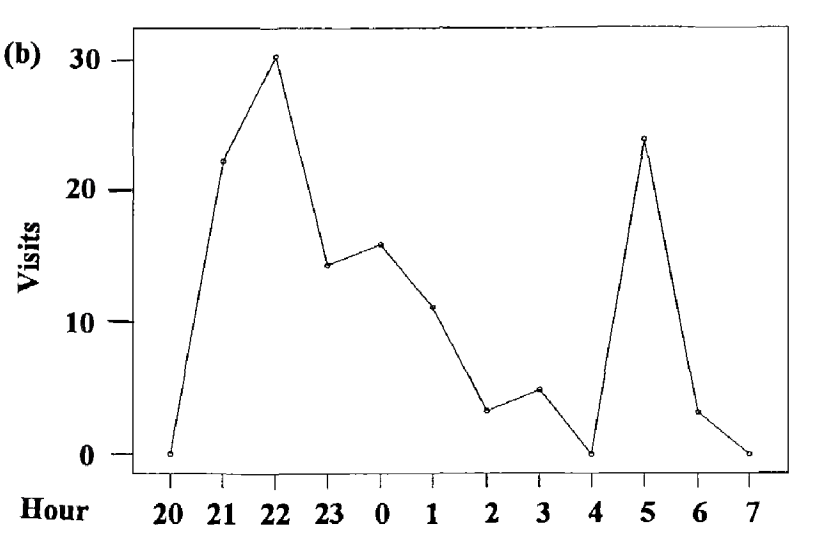


Figure 2. Nest visits by flammulated owls at Eyrie Canyon during the nights of 23 July (a) and 28 July (b), 1992

Twenty (83%) of the owl nests were in dead trees and four (17%) in live trees. Of these, 13 (54%) were in dead broken-top Douglas-fir snags and 11 (46%) in trembling aspens—seven (29%) in dead trees and four (17%) in live aspens. Mean dimensions for 13 nest sites were 49.9 cm (SD = 18.9) for diameter at breast height, 5.1 m (SD = 0.6) for cavity height; entrance diameter for 11 of the nests was 6.8 cm (SD = 1.3). Primary excavators of cavities within our study area were the northern flicker (*Colaptes auratus*), hairy woodpecker (*Picoides villosus*) and the yellow-bellied sapsucker (*Sphyrapicus varius*).

We were able to determine hatching or fledging dates at 11 of the 24 nests. Using 22 d for both the incubation and nestling periods (Reynolds and Linkhart 1987, Johnsgard 1988, McCallum 1994a) we calculated the mean hatching date for the 11 nests as 26 June (range, 12 June through 11 July) and mean fledging date as 18 July (range, 7 July through 2 August).

During the nestling stage at two nests, four all-night surveillances (Figs. 1 and 2) recorded 65, 93, 133, and 81 ($\bar{x}$ = 93) nocturnal nest visits by adult owls, primarily the male. These nightly food deliveries at nest sites peaked within the 2-hr periods after dark and before daylight.

Insect sampling in 1992 (Tables 1 and 2) recorded more smaller-sized invertebrates (37.6%) compared to larger potential prey (27.4%) and found lepidopterans to comprise 78.8% and orthopterans 0.3% of the prey sampled within the study area. Photographic analysis (Table 3) of 65 food deliveries at one nest

Table 1. Invertebrate sizes recorded at black-light sampling stations within the study area, summer 1992.

LOCALITY	DATE	NUMBER BY SIZE CLASS		
		SMALL (8–11 mm)	MEDIUM (12–13 mm)	LARGE (14+ mm)
Beaverdam Canyon	25 June	24	8	12
	2 July	0	2	9
Kossman Canyon	3 July	19	14	13
Eyrie Canyon	8 July	40	52	27
	13 July	38	35	22
	14 July	69	57	35
	23 July	18	11	22
	24 July	37	49	39
Totals		245 (37.6%)	228 (35.0%)	179 (27.4%)

identified 43.1% as orthopterans and 9.2% as lepidopterans. Observations at other nests (Table 3) revealed a predominance of lepidopteran prey.

A female owl was captured in the same territory in 1992, 1993 and 1994; nesting in the same cavity the first 2 yr but in a different snag the third year. Her mate was not banded in 1992 but was known to occupy that territory in 1993 and 1994. Another male nested in different snags 60 m apart in 1991 and 1993, but could not be identified during 1992 and 1994 when no occupied nests could be found within that territory. A third male, nesting in 1988 was recaptured again in 1991 in a mist net 50 m from the 1988 nest tree. We did not sample the area between 1988 and 1991.

DISCUSSION

Although spring arrival dates for flammulated owls in Idaho are not well-documented, the mid- to late-May arrivals in our study area seem comparable to the few records elsewhere in the state. For example, singing owls were heard on 10 May in the Salmon National Forest (Atkinson and Atkinson 1990), on 24 May 1991 in westcentral Idaho (Moore and Frederick 1991), and a migrating flammulated owl was photographed roosting in a black-billed magpie (*Pica pica*) nest near Boise, Ada County, Idaho on 16 May 1970 (E. Thompson pers. comm.). Owls may have arrived earlier in May some years since the number of consecutive days we spent in the study area was limited and inclement weather occasionally prevented our early access to the study area.

Table 2. Invertebrates recorded at black-light sampling stations in the study area, summer 1992.

INVERTEBRATE	NUMBER SAMPLED	PERCENT
Lepidoptera	514	78.8
Diptera	112	17.2
Coleoptera	15	2.3
Dermaptera	7	1.1
Orthoptera	2	0.3
Arachnida	2	0.3
Totals	652	100

Reynolds and Linkhart (1992) reported that with the exception of a single nest in a piñon pine (*Pinus edulis*) in California, all reported nests of the flammulated owl occur in forests containing at least some ponderosa pine (*Pinus ponderosa*). Recent studies have found this owl mostly avoiding the ponderosa pine belt in southern British Columbia (Howie and Ritcey 1987) and nesting in forests devoid of this pine in Nevada (S. Garland pers. comm.). Our study provides another exception in that ponderosa pine does not occur within our study area. Douglas-fir and aspen were the only tree species utilized by nesting owls in our study. Although this owl is known to occur in trembling aspen (Webb 1982), the high incidence of its utilization of this tree species for nest sites in our study area (46%) is apparently much greater than reported elsewhere. Our findings contribute to the mounting evidence that flammulated owls may not be so exclusively tied to ponderosa pine as much of the earlier literature indicates.

Nesting phenology is not well-documented for the flammulated owl throughout its range. In Colorado

Table 3. Prey delivered to four flammulated owl nests, 1991–93.

PREY CATEGORY	1991[a]	1992[b]	1993[c]	TOTALS
Orthoptera	1 (4.3%)	28 (43.1%)	5 (13.9%)	34 (27.4%)
Coleoptera	0 (0)	5 (7.7%)	0 (0)	5 (4.0%)
Diptera	3 (13.0%)	0 (0)	0 (0)	3 (2.4%)
Lepidoptera	9 (39.1%)	6 (9.2%)	29 (80.5%)	44 (35.5%)
Larva	10 (43.5%)	2 (3.1%)	2 (5.6%)	14 (11.3%)
Unidentified	0 (0)	24 (36.9%)	0 (0)	24 (19.4%)
Totals	23	65	36	124

[a] Beaverdam/Side Canyon nest (29 July, dusk-to-dawn observations).
[b] Photographic analysis of prey delivered to Eyrie Canyon nest (23 and 28 July, dusk-to-dawn observations).
[c] Beaverdam/Side Canyon nest and Beaverdam Base Camp nest (7, 8, 18 and 27 July, partial-night observations).

the mean date at which the last egg hatched was 29 June (Reynolds and Linkhart 1987) and 30 June was given as the hatching date at a single flammulated owl nest in southwestern Idaho (Hayward 1986). Our mean hatching date (26 June) may seem early considering the northern extent of our study area and the migratory demands on our owls compared to the more southern Colorado birds. However, even though more southern in latitude, the 350–1300 m higher elevation of the Colorado habitat where snow lingered until early May (Reynolds and Linkhart 1987), likely places their owls into a similar nesting phenology.

Productivity data from our study are limited but the observed brood size ($\bar{x} = 2.3$) of nine nests appears lower than reported for most other populations (McCallum 1994a) except in New Mexico (McCallum et al. 1995), and may support the view that ponderosa pine is the most productive habitat for this owl, even if not the only one used (D.A. McCallum pers. comm.).

In southwest Idaho, Hayward (1986) recorded 54–97 nest visits per night by adults during 9 d of the nestling period. Numerous nocturnal observations by Reynolds and Linkhart (1987) at nests in Colorado all terminated at 0300 H and thus cannot be directly compared to either Hayward's (1986) or our data. However, the food delivery rate at Colorado nests peaked at over 16 trips per hour during the 8–12 d after hatching (Reynolds and Linkhart 1987). Our maximum nest visits per night (133) and peak visits per hour (>30; Figs. 1 and 2) exceed those reported elsewhere. Like Hayward (1986), we observed a greater number of food deliveries early in the night, following the lengthy diurnal fasting period.

Although small vertebrate prey has been documented at flammulated owl nests (Linkhart and Reynolds 1994), as elsewhere (Hayward 1986, Reynolds and Linkhart 1987) we observed only invertebrate prey, predominantly small lepidopterans, being delivered to nests. Orthopterans, which comprised only a minor part of this owl's food in other studies (Hayward 1986, Reynolds and Linkhart 1987, McCallum 1994a), were the predominant prey (43.1%) during the late nestling stage at one of our 1992 nests (Table 3), despite their concurrent low incidence at the black-light sampling stations within the study area (Table 2). During that same time, we observed a general surge of crepuscular and nocturnal activity of the shield-backed katydid (*Neduba carinata*) along roadside areas in proximity to the nest, suggesting that the owls were opportunistically utilizing this abundant food source. Otherwise, prey selection at our nests followed the usual predominance of lepidopterans (Table 3). Goggans (1986) found that food habits of Oregon owls shifted from noctuid moths early in the summer to orthopterans later. Our sampling of potential prey with the black-light station seemed effective for most nocturnal insects but did not attract many orthopterans (pers. obs.), hence their scarcity in our samples may merely reflect a sampling bias.

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